Dynamic Analysis And Control System Design Of Automatic Transmissions

The modeling techniques used to simulate the dynamic performance of the KIPS Power Conversion System fluid loops as presented at the third design review in December 1976 are discussed. A companion topical report titled KIPS Control System Selection described the overall control system requirements, selection and function of components, and a recently completed trade-off of the present hydromechanical valve against an electromechanical approach to the control valve package. The KIPS utilizes two speed modes (1) essentially constant speed in orbital operation by utilization of parasitic loads to compensate for varying spacecraft loads and (2) Speed Wild for launch and other high vibration environments when a higher speed is desirable to provide added bearing load capability and the corresponding extra pump output pressure is available to provide higher jet velocity in the jet condenser. In this later mode the parasitic loads are non-operative and the speed will vary with the spacecraft load demand. The analysis presented here shows that the KIPS is dynamically stable under all operating conditions. Further analysis and refinement is planned for the Phase II program.


The finite element, an approximation method for solving differential equations of mathematical physics, is a highly effective technique in the analysis and design, or synthesis, of structural dynamic systems. Starting from the system differential equations and its boundary conditions, what is referred to as a weak form of the problem (elaborated in the text) is developed in a variational sense. This variational statement is used to define elemental properties that may be written as matrices and vectors as well as to identify primary and secondary boundaries and all possible boundary conditions. Specific equilibrium problems are also solved. This book clearly reveals the effectiveness and great significance of the finite element method available and the essential role it will play in the future as further development occurs.

This book presents a general framework for modelling power system devices to develop complete electromechanical models for synchronous machines, induction machines, and power electronic devices. It also presents linear system analysis tools that are specific to power systems and which are not generally taught in undergraduate linear system courses. Lastly, the book covers the application of the models, analysis and tools to the design of automatic voltage controllers and power system stabilisers, both for single-machine-infinite-bus systems and multi-machine interconnected systems. In most textbooks modelling, dynamic analysis, and control are closely linked to the computation methods used for analysis and design. In contrast, this book separates the essential principles and the computational methods used for power system dynamics and control. The clear distinction between principles and methods makes the potentially daunting task of designing controllers for power systems much easier to approach. A rich set of exercises is also included, and represents an integral part of the book. Students can immediately apply—using any computational tool or software—the essential principles discussed here to practical problems, helping them master the essentials. This study provides a thorough understanding of the principles and methods of dynamic analysis, showing how it can be applied to the analysis of vibrating systems and the study of control system dynamics.

Using a simplified system model consisting of a pump, transmission line, and load value, a general procedure is devised for analyzing the dynamic performance of a hydraulic control...
system. Mathematical models are developed for each component in terms of the pressures and flows into and out of the component. The individual models are combined into a complete system model which is used to simulate system operation on a hybrid computer. Simulation of pump operation without the transmission line attached is also performed on hybrid and digital computers. (Modified author abstract).

This book is concerned with a quantitative analysis of dynamic behavior of various enzymatic reaction systems by computer simulation. The authors and coworkers have been engaged in cooperative research since 1975, seeking to clarify the catalytic and regulatory characteristics of enzymatic reactions in vivo and control mechanisms suitable for enzyme technology. Rather than "enzyme kinetics" generally known in enzymology, this research has employed an approach called "enzyme dynamics" which concentrates on the exact schematic representation of an actual reaction mechanism, derivation of rate equation on the basis of the scheme, and computer simulation of its dynamic behavior (numerical solution of the rate equation and explanation of kinetic and regulatory properties of the enzymatic reaction). A rate equation representing the behavior of enzymatic reactions is generally expressed by a set of nonlinear differential equations. The analytic solution of rate equations is therefore impossible in general, making it necessary to introduce some approximations in order to analyze the experimental data in enzyme kinetics. For example, under an assumption of excess substrate against enzyme in a closed system, we commonly use the linear approximation for the early period of reaction, the quasi-steady state approximation based on putative maintenance of steady state in enzyme species, and the rapid-equilibrium approximation assuming instantaneous equilibration in complex formation and between complexes. The kinetic characteristics obtained by these approximations do not always reflect the dynamic behavior of actual enzymatic reactions.

This text deals with matrix methods for handling, reducing, and analyzing data from a dynamic system, and covers techniques for the design of feedback controllers for those systems which can be perfectly modeled. Unlike other texts at this level, this book also provides techniques for the design of feedback controllers for those systems which cannot be perfectly modeled. In addition, presentation draws attention to the iterative nature of the control design process, and introduces model reduction and concepts of equivalent models, topics not generally covered at this level. Chapters cover mathematical preliminaries, models of dynamic systems, properties of state space realizations, controllability and observability, equivalent realizations and model reduction, stability, optimal control of time-variant systems, state estimation, and model error concepts and compensation. Extensive appendixes cover the requisite mathematics.

This textbook is ideal for a course in engineering systems dynamics and controls. The work is a comprehensive treatment of the analysis of lumped parameter physical systems. Starting with a discussion of mathematical models in general, and ordinary differential equations, the book covers input/output and state space models, computer simulation and modeling methods and techniques in mechanical, electrical, thermal and fluid domains. Frequency domain methods, transfer functions and frequency response are covered in detail. The book concludes with a treatment of stability, feedback control (PID, lead-lag, root locus) and an introduction to discrete time systems. This new edition features many new and expanded sections on such topics as: solving stiff systems, operational amplifiers, electrohydraulic servovalves, using Matlab with transfer functions, using Matlab with frequency response, Matlab tutorial and an expanded Simulink tutorial. The work has 40% more end-of-chapter exercises and 30% more examples.

Written to inspire and cultivate the ability to design and analyze feasible control algorithms for a wide range of engineering applications, this comprehensive text covers the theoretical and practical principles involved in the design and analysis of control systems. From the development of the mathematical models for dynamic systems, the author shows how they are
used to obtain system response and facilitate control, then addresses advanced topics, such as digital control systems, adaptive and robust control, and nonlinear control systems. The Dynamics of Automatic Control Systems focuses on the dynamics of automatic control systems and the fundamental results of the theory of automatic control. The discussion covers theoretical methods of analysis and synthesis of automatic control systems common to systems of various physical natures and designs. Concrete examples of the simplest functional circuits are presented to illustrate the principal ideas in the construction of automatic control systems and the application of the theoretical methods. Comprised of 19 chapters, this book begins by describing different forms of automatic control systems, with emphasis on open and closed loop automatic systems. The reader is then introduced to transients in automatic regulation systems; methods for improving the regulation process; and some problems in the theory of automatic regulation. Subsequent chapters deal with linearization and transformation of the differential equations of an automatic regulation system; stability criteria for ordinary linear systems; equations of systems with delay and with distributed parameters; and equations of nonlinear automatic regulation systems. The oscillations and stability of nonlinear systems are also considered. This monograph will be of interest to engineers and students.

A textbook for engineers on the basic techniques in the analysis and design of automatic control systems.

Provides technical details and developments for all automotive power transmission systems. The transmission system of an automotive vehicle is the key to the dynamic performance, drivability and comfort, and fuel economy. Modern advanced transmission systems are the combination of mechanical, electrical and electronic subsystems. The development of transmission products requires the synergy of multi-disciplinary expertise in mechanical engineering, electrical engineering, and electronic and software engineering. Automotive Power Transmission Systems comprehensively covers various types of power transmission systems of ground vehicles, including conventional automobiles driven by internal combustion engines, and electric and hybrid vehicles. The book covers the technical aspects of design, analysis and control for manual transmissions, automatic transmission, CVTs, dual clutch transmissions, electric drives, and hybrid power systems. It not only presents the technical details of key transmission components, but also covers the system integration for dynamic analysis and control. Key features: Covers conventional automobiles as well as electric and hybrid vehicles. Covers aspects of design, analysis and control. Includes the most recent developments in the field of automotive power transmission systems. The book is essential reading for researchers and practitioners in automotive, mechanical and electrical engineering.

Gear shifting in today's automatic transmissions is a dynamic process that involves synchronized torque transfer from one clutch to another, smooth engine speed change, engine torque management, and minimization of output torque.
disturbance. Dynamic analysis helps to understand gear shifting mechanics and supports creation of the best design for gear shift control systems in passenger cars, trucks, buses, and commercial vehicles.

Design of modern digital hardware systems and of complex software systems is almost always connected with parallelism. For example, execution of an object-oriented program can be considered as parallel functioning of the co-operating objects; all modern operating systems are multitasking, and the software tends to be multithread; many complex calculation tasks are solved in distributed way. But designers of the control systems probably have to face parallelism in more evident and direct way. Controllers rarely deal with just one controlled object. Usually a system of several objects is to be controlled, and then the control algorithm naturally turns to be parallel. So, classical and very deeply investigated model of discrete device, Finite State Machine, is not expressive enough for the design of control devices and systems. Theoretically in most of cases behavior of a controller can be described by an FSM, but usually it is not convenient; such FSM description would be much more complex, than a parallel specification (even as a network of several communicating FSMs).

There are various techniques to optimize either structural parameters, or structural controllers, but there are not many techniques that can simultaneously optimize the structural parameters and controller. The advantage of integrating the structural and controller optimization problems is that structure and controller interaction is taken into account in the design process and a more efficient overall design (lower control force/lighter weight) can be achieved, and also multidisciplinary design optimization can be performed. The down side is that the combined optimization problem is more difficult to formulate and solve, and computations are increased. This volume is a comprehensive treatment of dynamic analysis and control techniques in structural dynamic systems and the wide variety of issues and techniques that fall within this broad area, including the interactions between structural control systems and structural system parameters.

Most machines and structures are required to operate with low levels of vibration as smooth running leads to reduced stresses and fatigue and little noise. This book provides a thorough explanation of the principles and methods used to analyse the vibrations of engineering systems, combined with a description of how these techniques and results can be applied to the study of control system dynamics. Numerous worked examples are included, as well as problems with worked solutions, and particular attention is paid to the mathematical modelling of dynamic systems and the derivation of the equations of motion. All engineers, practising and student, should have a good understanding of the methods of analysis available for predicting the vibration response of a system and how it can be modified to produce acceptable results. This text provides an invaluable insight into both.

Gain an in-depth understanding of converter-interfaced energy storage systems
with this unique text, covering modelling, dynamic behaviour, control, and stability analysis. Providing comprehensive coverage, it demonstrates the technical and economic aspects of energy storage systems, and provides a thorough overview of energy storage technologies. Several different modelling techniques are presented, including power system models, voltage-sourced converter models, and energy storage system models. Using a novel stochastic control approach developed by the authors, you will learn about the impact of energy storage on the dynamic interaction of microgrids with distribution and transmission systems. Compare the numerous real-world simulation data and numerical examples provided with your own models and control strategies. Accompanied online by a wealth of numerical examples and supporting data, this is the ideal text for graduate students, researchers, and industry professionals working in power system dynamics, renewable energy integration, and smart grid development. The Dynamic Analysis and Control System Design of a Hydroski

While the basic working principle and the mechanical construction of automatic transmissions has not changed significantly, increased requirements for performance, fuel economy, and drivability, as well as the increasing number of gears has made it more challenging to design the systems that control modern automatic transmissions. New types of transmissions continuously variable transmissions (CVT), dual clutch transmissions (DCT), and hybrid powertrains have presented added challenges. Gear shifting in today’s automatic transmissions is a dynamic process that involves synchronised torque transfer from one clutch to another, smooth engine speed change, engine torque management, and minimisation of output torque disturbance. Dynamic analysis helps to understand gear shifting mechanics and supports creation of the best design for gear shift control systems in passenger cars, trucks, buses, and commercial vehicles. Based on the authors graduate-level teaching material, this well-illustrated book relays how the fundamental principles of hydraulics and control systems are applied to today’s automatic transmissions. It opens with coverage of basic automatic transmission mechanics and then details dynamics and controls associated with modern automatic transmissions. Topics covered include: gear shifting mechanics and controls, dynamic models of planetary automatic transmissions, design of hydraulic control systems, learning algorithms for achieving consistent shift quality, torque converter clutch controls, centrifugal pendulum vibration absorbers, friction launch controls, shift scheduling and integrated powertrain controls, continuously variable transmission ratio controls, dual-clutch transmission controls, and more. The book includes many equations and clearly explained examples. Sample Simulink models of various transmission mechanical, hydraulic and control subsystems are also provided. Chapter Two, which covers planetary gear automatic transmissions, includes homework questions, making it ideal for classroom use. In addition to students, new
engineers will find the book helpful because it provides the basics of transmission
dynamics and control. More experienced engineers will appreciate the theoretical
discussions that will help elevate the reader's knowledge. Although many
automatic transmission-related books have been published, most focus on
mechanical construction, operation principles, and control hardware. None tie the
dynamic analysis, control system design, and analytic investigation of the
mechanical, hydraulic, and electronic controls as does this book.
Control and Dynamic Systems: Advances in Theory and Applications, Volume 42: Analysis and
Control System Techniques for Electric Power Systems, Part 2 of 4 covers the research
studies on the significant advances in areas including economic operation of power systems
and voltage and power control techniques. This book is composed of eight chapters and
begins with a survey of the application of parallel processing to power system analysis as
motivated by the requirement for faster computation. The next chapters deal with the issues of
power system protection from a system point of view, the voltage stability phenomenon, and an
overview of the techniques used in the reliability evaluation of large electric power systems.
These chapters also look into the reliability assessment of bulk power systems, which are the
composite of generation and high-voltage transmission, often called composite systems. These
topics are followed by investigations of the potential of integer quadratic optimization to
improve efficiency in a radial electric distribution system through the coordination of switched
capacitors and regulators. Other chapters consider the issues of the optimal operation of a
power system that are substantially complicated as a result of the large system scale nature of
these issues. The final chapters explore the techniques for achieving requisite speed
improvements that are essential to electric power systems and the problems on effective
methods in hydro optimization. This book will be of value to electrical engineers, designers,
and researchers.

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